A Multilevel Analysis of Commercial Software Online Help Forums

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Summary

Learning and using complex software has shown to be a challenging and often frustrating task. When encounter problems in using a software application, an important channel that can help users to resolve their issues is the online software help forums. By leveraging methodologies of analysis from previous research about various online discussion sites, we conducted a multi-level analysis on three commercial software help forums (e.g. Photoshop, AutoCAD, and Sonar) focusing on an important yet understudied question: "how commercial software users leverage the online help forums to communicate software learning/usage experiences?"

Our results showed that, comparing with general online forums (or discussion sites), the help forums dedicated to commercial software demonstrate their own characteristics in overall statistics related to posting behaviors, the discussed problems opening the threads, and the flow of communications in threads for solving such problems. The most common help-seeking behavior in current commercial software help forums is for dealing with error/stuck situations while using the application to accomplish specific task. To solve such raised software problems, the flow of communication in threads most likely involves more than one rounds of discussion about the possible solutions among the asker and several repliers. In spite of such significant effort that software users have spent in solving problems, current help forums still exist several inefficiencies, such as the textual and delayed fashion of communication increasing the difficulties of explaining and understanding the problem description, and the lack of tracking the history of user operations reducing the probability of sharing experience and rewarding the solutions.

Leveraging on our analysis results, we conclude this thesis with discussing the insights and possible contributions for different audiences.

General Terms:

Help-seeking, help-giving, Online Discussion sites, Software learning

Additional Key Words and Phrases:

Commercial software support, qualitative content analysis, online user interview

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1. Introduction

1.1. Background

As technique advances, software applications have become increasingly more powerful, characterized by enhanced capabilities and richer functionalities. Accompany the growing complexity is the raised challenges in learning and using them, which have caused significant frustration among users [14, 36].

For commercial software, traditional methods for users to seek help include manual documentations [31, 63] and technical support (e.g. specialist-based and one-to-one conversation) [12]. The former has its limitations as it is difficult to cover different users' problems with flexible system setting and various contexts, while the latter costs the company tremendous amount of human resource and financial overhead [1, 12]. Theories in learning and education has predicted that people prefer to learn software in a social context [26, 27, 38]. It is thus somewhat surprising that community-based software learning methods such as online software forums have not received much attention in the research field [28].

Compared with traditional software help methods such as manual documentations, software online help forum stands out as a unique channel since its generated help knowledge comes from the entire community, instead of a few experts. Furthermore, individual users ask for help from the peers, instead of from prefixed documentations. The conversations in such forums are typically organized as threads, which starts with an opening post that initials a discussed issue and follows with multiple users collaboratively posting their opinions [16].

Activities in such help forums contain rich information about the problems users have about the software and the challenges they face when seeking help in the community. To provide better software support, it is important to understand the uniqueness and the effectiveness of the software help forums.

1.2. Summary of Previous Work

Software help forum, as its name indicates, is a type of online discussion sites dedicated to help topics related software applications. Online discussion sites in general are not restricted to this specific topic. For example, Yahoo! Answer is a general-purpose online discussion site where everyone can ask questions about anything. Much previous work studied these general sites, typically focused on the following three aspects: revealing the overall dynamics of these sites [33, 61], classifying the content of threads and posts [39, 53], and exploring the users' motivations/attitudes [7, 45]. Results from these studies, while being insightful, cannot be directly applied to software help forum as the user community has a much narrower shared interest that's specific to the learning/usage of particular software applications.

Limited previous work also studied online discussion site dedicated to software applications. For example, Singh et al. initially studied the Open Source Software (OSS) help forums [59, 60] with a limited number of threads (e.g. 80 threads from 8 OSS forums) and revealed the possible types of users' questions, such as "how-to" or "error/stuck". While considering the essential differences between open source and commercial software [49], such as the community-updated nature of OSS, we believe that the commercial software help forums have their own particularities that warrant a separate study.

1.3. Research Question & Methodology

In this thesis, we chose the official help forums of three popular commercial software applications: Adobe Photoshop, Autodesk AutoCAD, and Cakewalk Sonar Producer. We aim to find out: *How commercial software users leverage the online help forums to communicate software learning/usage experiences?*

To gain a more holistic picture, we took a mixed analysis approach involving three levels:

1. Statistical analysis of one-year posted threads in the three forums to represent the dynamic of forums. It provides a macro analytical view about software users' posting behavior.
2. Qualitative analysis of 1200 threads sampled from the one-year time window to gain insights of the discussed content in the opening posts and following communication patterns. It explores a micro aspect of software users' posting content.
3. Online interview through email of 18 forum users to reveal their considerations and attitudes about online posing activities.

1.4. Result Summary

Our results show the specialties of the commercial software forums from several aspects. First, compared with general-purpose online discussion sites, users in commercial software help forums show stronger sense of belonging to the community, demonstrated by a much higher response rate. Second, by characterizing the opening posts in threads from three dimensions (e.g. type, topic, and scope), it finds out that the most common help-seeking behavior is for users encountering "error/stuck" situations (type) while accomplishing specific tasks (topic) within the application (scope). Third, with such various opening posts being raised, the followed posts in threads are classified into five categories to capture users' communication: problem definition (PD), problem evolution (PE), suggestion evolution (SE), problem closure (C), and discussion/socialization (DS). By further identifying six communication patterns with different categories of posts, it suggests that a raised question can get solved through three different paths: the process of question clarification, the discussion about possible suggestions, and the self-closure by the askers themselves who gain solutions from other help channels and come back to reward the community.

Additionally, we observe that different commercial software forums also exhibit dissimilarities in the posting dynamics, which in turn affect the occurrences of discussion topics and communication patterns. In particular, Sonar has more social characteristic as its users pay more attention about establishing social relationship among the community, while AutoCAD users are more problem-driven and concentrate in discussing technical suggestions. The active social behavior in Sonar has led to more Sharing type of opening posts and more irregular (branched) conversations in threads. Further statistic calculations also hint that building the social bound among different forum members may help to motivate more collaboration in proposing suggestions and solving problems.

1.5. Contribution

Our contributions focus on identifying the users' help seeking/giving activities in the collaborative problem solving process in the commercial software help forums. More specifically, first, we examine the problems users encountered in software learning/usage from the opening posts, which can benefit software companies to better understand users' needs/requirements. Second, we reveal the common communication patterns and their relative distributions across different forums, which can be treated as a reference point for researchers to compare with when developing future community-based software help tools. Third, we discuss the deficiencies in current help forums, which can inspire forum designers to create more helpful forums in the future.

1.6. Thesis Roadmap

The remaining sections of this thesis are organized as follows. Section 2 summarizes the related work about understanding various online discussion sites. The methodologies of our work are explained in section 3. Sections 4 - 6 represent the results from our three-level

analysis: statistical analysis, qualitative analysis, and user interview. Section 7 discusses the possible design directions and implications based on our analysis results.

2. Related Work

Discussion forums are online discussion sites where people can hold conversations in the form of posted messages [2]. The various online discussion sites in Internet can serve different purposes. For example, Yahoo! Answer [33] and Usenet newsgroups [52] are general-purposed which allow people to discuss various topics. On the other hand, the technical support boards normally have more specific discussed issues, such as Network-board [61] which provides avenue for people to deal with network setup issues. Even in the software help/learning domain, the discussion forums are separated based on different types of software, such as Open source software applications (e.g. Firefox forum [59]), or commercial software applications (e.g. Photoshop forum).

Extensive research has been done in studying the former three types of online discussion sites. Previous analysis can be roughly divided into the following three categories: 1) analyzing the overall dynamics of forums; 2) classifying the content of threads and posts; 3) revealing the users' considerations and feedback.

2.1. Forum Dynamic

2.1.1. Overview

To investigate the overall forum dynamics, previous studies defined different statistic metrics to quantify users' posting behaviors [3, 29, 51]. Based on these metrics, different visualization techniques [20, 21, 23] and network analysis tools [13, 32, 33] have been used to 1) present the activity level of a forum community and 2) reveal the different clusters of forums.

2.1.2. Activity level

Regarding the activity level of a forum community, typical statistic metrics contain the post number per user, the response rate, the number of questions/replies a user posted on average, and the post number per thread, etc.

By examining the post number per user, it was found that, in online discussion sites, the users' posting behaviors typically follows the power law distribution [42], which means a small number of users often make a large number of posts while the remaining majority of users only contributes a small number of posts. Such power-law distribution of posting behavior has been discovered in many different types of online communities, including Usenet newsgroups [51], Wikipedia edits [30] and general-purpose Q&A sites [33].

Furthermore, Yardi et al. stated that response rate and response time are two of the basic metrics for measuring the activity level in an online community [62]. A low response rate indicates "the repeated failures to start conversation [51]". For Usenet newsgroups, Smith et al. examined the posted messages within 150-day period in 1997 and found that only 21% of the threads obtained response [54]; and Whittaker et al. tested 26 top-level newsgroups in Usenet, which also showed a lower response rate than 60% [51]. For Yahoo! Answer, Dearman el al. found that, across different categories, between 5% and 53% questions have no response [15]. As Yahoo! Answer is one of the largest community-based Q&A sites and emphasizes the newest content [33]; it indicated that, even with high traffic load, forum users still have difficulty in starting conversations in such public platform.

Zhang et al. studied the number of questions/replies that users post in the forum for Java and defined three groups of users: question person (who ask), answer person (who respond), and discussion person (who perform both) [21, 64]. For both Usenet and Q&A sites, it has been verified that the answer persons played influential roles in generating the help content in

the forums [13, 21]. Also, Adamic et al. discovered that the community in Yahoo! Answer has a further separation of question persons and answer persons [33]. And Nam et al. examined a Q&A site in South Korea which revealed "people who ask normally don't answer" [29]. They found out that only 5.4% of the community contributes in both questions and answers.

Moreover, users' posting data suggested that these different statistic metrics are correlated with each other. In Fiore et al.'s study about Usenet, they verified that a user's posting behavior (e.g. the frequency of the user's posts or the total number of post) highly correlated with other people's subjective evaluation of that user [3]. For example, people's desire to read more about an author positively correlates with the number of posts that the author posted to one focal newsgroup, but negatively correlates with the number of newsgroups the authors ever contributed. Additionally, Whittaker et al. also found out that, in Usenet, different statistic metrics, such as the length of posts or the number of posts per thread, often correlate with each other [51]. For example, the longer the replies are in a thread, the fewer replies the thread may get.

These statistic metrics helped researchers to support better community-based help. For example, Zhang et al. introduced an expertise-finding mechanism, which automatically inferred the expertise level for different users based on the number of question/answer they contributed [64]. Additionally, Welser et al. visualized different groups of users based on their posting behaviors and confirmed that such visualization techniques can enhance the users' awareness about other who shared similar posting patterns [13, 20].

2.1.3. Forum cluster

Besides the activity level of a forum community, another aspect of the dynamic of forums is categorizing them into different clusters.

Yahoo! Answer and Usenet newsgroups are general-purpose online discussion sites, in any user can ask anyone about anything [3, 18, 22]. In Yahoo! Answer and Usenet newsgroups, there consist of different forums for users to discuss various topics. Typical statistic metrics for clustering these different categories are the number of users who posted only once, the number of posts per thread, and the length of posts per thread on average etc.

For Usenet, Fisher et al. examined the percentage of users who posted only once out of nine forums [13]. It showed that in technical newsgroups (e.g. comp.soft-sys.matlab newsgroup), it has a relatively large number of users who posted only once (41% - 50%), while the socialization/discussion newsgroups (e.g. alt.support.divorces) have smaller number of users who posted only once (20% – 32%). Moreover, by examining the number of posts per threads, it was discovered that a large amount of threads in technical newsgroups have less than five replies (e.g. 80% - 90%), while for the socialization/discussions newsgroups, the percentage of such threads is much smaller (e.g. 40% - 47%).

For Yahoo! Answer, Adamic et al. inferred different forums in such site are a "mix of request for factual information, advice seeking, and social conversation or discussion" [33]. To determine the clusters of forums, the authors calculated the average number of posts per thread, the average length of posts per thread, and the overlap of asker and replier on average for each forum. Noted, the overlap of asker and replier is defined as the cosine similarity between the number of questions and the number of replies for each user. The greater the cosine similarity value is, the more people who contribute both questions and replies. Their results showed that, by comparing with forums for socialization/discussion (e.g. Movie), forums for requesting factual information (e.g. Programming) have less posts per thread, shorter posts per thread, and smaller overlap of asker and replier.

Looking into both Usenet and Yahoo! Answer, it can be seen that similar clusters of forums (e.g. forums with technical characteristic vs. forums with social characteristic) have been observed.

2.1.4. Lessons

We summarize the statistic metrics used and its main results in Table 1.

Table 1. The main result summary from previous work about forum dynamic

Forum dynamic	**Statistic metrics**	**Common trends in general-purposed online discussion sites**
Activity level	Post number per user	Power law distribution
	Response rate	Relative low response rate
	Number of questions/replies per user	People who ask normally don't answer; Few users who contribute both questions and replies
Forum Cluster	Number of users who posted once	Forums with technical characteristic vs. Forums with social characteristic: Social factor leads to fewer users who posted once, fewer posts per thread, and larger overlap of asker and replier
	Number of posts per thread	
	The overlap of asker and replier	

The previous work provides valuable information of the overall picture about forum dynamics using different statistic metrics. For our work, we are interested to find out whether

the above common trends which exist in general-purposed discussion sites can also be observed in commercial software help forums.

2.2. Thread & Post Content

2.2.1. Overview

In addition to represent the dynamic of forums, various approaches and theories have been applied to analyze the content of users' posts in different discussion sites. The most basic property of an online discussion site is its help content, generated from the entire community, instead of a few experts. In regards to generating help content in the form of posts, researchers normally specify it as help seeking content, such as "raise a question", and help giving content, such as "describe a solution".

2.2.2. Help seeking content

For general-purpose discussion site (e.g. Yahoo! Answer), users can ask questions on any topic for the community to answer [22]. Considering its popularity and high traffic load, it is somewhat surprising that "there is little research that seeks to understand what questions people ask" [18]. Existing studies have focused on different aspects when investigating posted questions in online discussion sites.

Based on the askers' general purposes, Harpe et al. examined the archival quality of the questions from three popular Q&A sites and classified them into two categories: informational questions (e.g. "what are the difference between A and B") and conversational questions (e.g. "do you believe in evolution?") [22]. By using machine-learning techniques [6], it is found that these two categories of questions could be automatically distinguished based on the category of belonged forums, the linguistic characteristic, and the authors' posting patterns.

More specifically, instead of focusing on askers' general purpose, Yardi and Poole emphasized the topics of the questions [62]. By applying the qualitative coding procedure [11], they examined the askers' posts from two technical support boards for network setup. It was found that the most frequent help seeking content is "request for trouble-shooting help" and "request for purchasing or warranty advice".

Similarly, Singh et al. also applied the qualitative coding procedure and studied 160 threads from 8 OSS forums (20 threads each) [59]. But they were interested in the language composition of questions and generated categories based on the types of questions, such as "how-to" or "error, stuck".

2.2.3. Help giving content

Corresponding to help seeking is help giving content, which largely indicates the help power of such forum community. When analyzing help giving content, researchers have generated their categories based on different criteria.

The most basic criterion is considering the content of a single post. Krichmar and Preece performed the interaction process analysis [8] to examine the users' posts in an online health community [39]. Different posts were classified based on the content: ask for/give information, opinion, and suggestion. Such categorizations emphasized the content itself, instead of the roles the posts may play in the communication process. For example, based on this classification, "what does the question mean?" and "what does the solution mean?" should both belong to the category: ask-for-information. However, these two posts come from different authors (replier vs. asker) and it clearly serves different purposes in the communication (attempt-to-help vs. ask-for-help).

Another criterion is distinguishing the author's roles in the post. Yardi and Poole explored the communication in technique support boards [62] and generated post classification based

on whether the author is the original asker or replier. More specifically, an asker may "report back results of trying a step", while the repliers can "provide procedural advice" or "asking for clarification or details". This categorization revealed the potential flow of communication between askers and repliers in the problem solving process.

Singh et al. considered both the content of a single post and the role of authors when analyzing the users' posts from OSS help forums [59]. Their categorization contained two levels. The first level captured the roles of authors and included five broader categories, such as "type of questions" (asker), "more details needed" (replier), and "responses" (replier). In each broad category, the second level extended to a couple of specific categories, which considers the content of a single post. For example, for "more details needed", the specific categories had "system details needed", "more details of history", "more details of what is on the screen", etc. The authors also confirmed that the problem solving process in software help forums often involved more people than the conventional help-seeker and help-giver pair [60], which verified that collaborative help in forums is different with the traditional one-to-one specialist support.

2.2.4. Lessons

We summarize the criteria considered in previous categorizations and the methods used in Table 2.

Table 2. The summarized results of the analysis of post content

Content of posts	**Analysis method**	**Considered criteria**	**Examples of developed categorization**
Help-seeking content	Machine learning	General purpose	Informational question vs. Conversational question

	Qualitative coding procedure	Question topic	Request for purchasing advice
		Question type	How-to, error/stuck
Help-giving content	Interaction process analysis	Content of single post	Ask for information vs. Give information
	Qualitative coding procedure	Roles of post authors	Replier: provide procedural advice; Asker: report back of results of trying a step
		Both content of single post and the roles of authors	More details needed (replier): (system details; or more details of history)

These analyses about the content of posts provide important groundwork for us to expand upon with more analysis. Qualitative coding procedure has been showed as a promising analysis method to examine the content of posts and develop categorizations. For the help-seeking content, it suggests that both topics and types should be measured to characterize the posted questions. For help-giving content, in order to reveal the potential flow of the communication, it is important to reflect the roles of the authors and also the content of the single post.

2.3. User Motivation & Feedback

2.3.1. Overview

Besides posting statistic and content, human factor is also an essential aspect of an online discussion site. To understand the users' motivations and considerations about participating into the online community, survey and interviews are normally conducted to obtain first-hand user feedback.

2.3.2. Motivation for participation

People come to online discussion sites with diverse purposes [4, 58]. In [58], Rood et al. summarized the primary reasons for them to participate is as "seeking/sharing personal experiences, opinions, answers; exchanging social support". Users' participation in online discussion sites can be summarized as nonpublic participation and public participation.

The nonpublic participation in an online community is called "lurking" [45], which means never/rarely post but read others' post regularly [43]. Considering the composition of an online community, lurkers have been reported to be a silent majority in an online forum [40, 44]. There are quite a lot of studies that intends to explore such lurking behaviors [7, 30, 45]. For example, by carrying out a semi-interview with 10 members of online communities, Nonnecke et al. have summarized 79 reasons why lurkers lurk, such as "shy to post publicly" or "no enough time to formulate the post" [7].

Besides lurkers, in public participation (posting to the discussion sites), people also may go through different experiences. Lampe et al. found that the reasons for people to first come to the discussion site might be quite different with the reasons that led them to stay [35, 47]. For example, the users may come to the site seeking information, but obtain additional benefit, such as entertainment, and therefore would like to return to the site. Joyce et al. examined the threads initiated by a novice user, who has never posted before, too see whether the thread

will obtain its first reply, which in turn would largely affect the probability of the user to post again [17].

By understanding these motivations for both nonpublic and public participation, different theories and framework were proposed to elicit a more active and consistent public participation [9, 41, 46]. For example, Bishop et al. proposed a conceptual framework that captured the cognitions users used, to determine actions taken in an online community [9]. They suggested a rating system, whereby community members indicated whether they found a particular member trustworthy or not. It was believed that such mechanism could motivate users' in their desire to participate.

2.3.3. Influence of participation

In addition to revealing the purposes for people to participate, another aspect is to understand the influence of their online posting activities on other users experiencing similar problems.

Yardi et al. isolated the users' posts in technical support boards [62], which were related to the posters' personal life, such as posts that contained keywords like public holiday or family vacation, etc. They verified that, helping family members, buying gifts for the holidays, preparing children for the upcoming school year, and other personal contexts will influence the types of technical help people seek online. For example, the purchase of new computers and related consumer products may be closely aligned with the beginning of a school year.

Krichmar et al. interviewed the members from an online health community through email [39]. It was reported that, the users' membership in an online community improved their offline lives in a number of significant ways. For example, when discussing and learning with other forum members, the users can provide better medical care and treatment for their family and friends in real life. Additionally, Nonnecke et al. surveyed 1188 users from an online-

discussion-board community and reported that, people who contributed to the community are normally more optimistic and positive than people who lurked [45].

2.3.4. Lessons

Previous researchers have revealed users' motivations for participating and the possible influence given and obtained from their online posting activities. However, considering the users' posts within the thread context, another interesting topic is the users' attitudes/considerations in the process of solving a specific problem. For example, after finding his/her solutions elsewhere, what are the motives for the asker to return to her/his own thread and rewarding the community?

2.4. Positioning Our Work in Literature

In this thesis, we attempt to answer the question: "How commercial software users leverage online help forums to communicate software learning/usage experience?"

On one hand, the commercial software help forums aim at facilitating software users to communicate software related experience. Learning to use software has been shown as a long standing, and core problem for HCI research [36]. Many researchers have improved the software learn-ability via developing different types of tutorial formats, such as graphical visualization [24, 31], animated demonstration [55], or video-based learning aids [56]. In the domain of leveraging the strength of community, the OWL [19] and CommunityCommands [28] systems recommended the relevant commands to users based on the command usage patterns of other members of the user community.

On the other hand, the commercial software help forums share similarities with other online discussion sites as all of them are thread-based sites and support virtual communications among remote users. Previous studies about the analysis of software help forums focused on open source software and limited to a small sample of threads. In this

thesis, we hope the investigation of commercial software help forums can benefit two areas of research: the improvement of software learn-ability and the analysis of online discussion sites.

Through learning the applied methodologies from previous research about understanding different online discussion sites, we position this thesis in the literature as: a multilevel analysis of commercial software online help forums, which reveals the forum dynamic, post content, and users' considerations while solving software problems, with the hope of extending the analysis of online discussion site to software learning domain, and also contributing design implications for future research about software learn-ability.

3. Methodology

With the lessons learned from previous work, we now explain the target forums we chose and the multilevel analysis method in detail.

3.1. Target Forum

We chose three popular commercial software applications:

- *Adobe Photoshop*: A graphic editing program, produced by Adobe;
- *Autodesk AutoCAD*: A computer aided design software for 2D or 3D graphic design and drafting, produced by Autodesk;
- *Cakewalk Sonar Producer*: A digital audio workstation for editing, mixing, mastering and outputting audio, produced by Cakewalk.

All the three applications have rich functionalities, are challenging to master, and host active official discussion forums. Additionally, the three applications are also intentionally chosen as they represent a varied range of user size. While the exact numbers of users are unspecified, we check out the cumulative times of download from Download.com as a soft indicator of the potential user size. It turns out that, by 15th Sep., 2011, there are 14.6 million cumulative downloads for Adobe Photoshop, 1.5 million for Autodesk AutoCAD, and 0.17 million for Cakewalk Sonar Producer.

For each of the three applications, there exist several official or unofficial forums dedicated to different products. For example, in the Adobe official website, the forum for Adobe Photoshop Windows is different with the forum for Adobe Photoshop Mac. To study the most general trends, we choose the official forums that are officially supported by the software development company and host the largest total number of posts among all relevant products.

Therefore, the chosen forums dedicate to Adobe Photoshop Windows[1], Autodesk AutoCAD 2010[2], and Sonar Producer and Studio[3]. We believe that our choice of forums covers certain level of variability in commercial software help forums. By investigating the common trends that occur in all three forums, our results can represent a preferable comparable point for further research. For convenience, the three forums are referred to as *Photoshop*, *AutoCAD*, and *Sonar* in the rest of this thesis[4].

3.2. Method

Based on previous studies, our multilevel analysis methods investigate the three commercial software help forums from three different aspects: 1) quantitatively represent the dynamics of the forums through statistical analysis; 2) qualitatively examine the content of posts at the level of thread through qualitative content analysis; 3) understand the users' considerations and attitudes about the help they give and receive from the forum community through interview by email.

3.2.1. Statistic analysis

The first level of analysis aims at providing an overview of the forums from the quantitative perspective.

Statistical analysis: To conduct the statistic analysis, similar with previous work, we used statistical metrics to quantify the activity level and the characteristics of the three evaluated forums which can be contrasted and compared with other general-purpose online discussion sites. More specifically, we are interested to find out, what specialties commercial software help forums have, and what common trends in general-purpose online discussion sites can also be observed.

[1] http://forums.adobe.com/community/photoshop/photoshop_windows
[2] http://forums.autodesk.com/t5/AutoCAD-2010/bd-p/360
[3] http://forum.cakewalk.com/tt.aspx?&forumid=5&p=2113
[4] Noted, *Photoshop*, *AutoCAD* and *Sonar* also refer the software applications based on the context

Data preparation: In July 2010, we spent one week collecting all posted threads from the three evaluated forums within a 15-month time window (April 2009 – June 2010). A prior calculation showed that, 95% of threads would no longer receive new replies after the opening posts occurred three months later. To avoid analyzing ongoing threads, which may be still attracting more replies and introduces uncertainty for the status of conversation, we excluded the threads posted in the most recent three months (April 2010 – June 2010) and restricted the analyzed dataset within a 12-month time window (April 2009 – March 2010).

We summarized the basic statistics about the analyzed dataset in Table 3. There are some interesting effects noted. Photoshop has the largest number of involved users, which is unsurprising due to the software's popularity and the potential large user base. However, Sonar, with the smallest potential user base, has the most active forum community with the largest number of threads and posts. These data gives us the first hint about the active characteristics of Sonar community.

Table 3. Basic statistics about the analyzed dataset (time period: April 2009 – March 2010)

	Total number of threads	**Total number of posts**	**Total number of involved users**
Photoshop	9068	56506	7711
AutoCAD	4501	24044	3596
Sonar	17283	167563	6193

For a better explanation of the results, the applied statistic metrics and the contrast/comparison with general-purpose online discussion sites will be discussed in the statistical analysis result section (Section 4) later.

3.2.2. Qualitative content analysis

The second level of analysis intends to investigate the generated help content at the level of threads from a qualitative perspective.

A typical thread in software help forums is initiated with an opening post (help-seeking) followed by multiple users' posts to communicate the solution for the raised problem (help-giving). By investigating the content of posts within threads, we aim at 1) identifying the users' confusions and expectations regarding learning or using the software, and 2) classifying the communication patterns in the collaborative process of problem solving.

Qualitative content analysis: We chose qualitative content analysis as the method to develop the categorizations for classifying different opening posts and the posts in the communication. Qualitative content analysis is a research method for subjective interpretation of the content of text data through systematic classification process of coding and identifying themes and patterns [23].

Zhang et al. have defined 8 standard steps to conduct qualitative content analysis: 1) preparing the data, 2) defining the unit of analysis, 3) developing a coding scheme, 4) testing the coding scheme on a sample of text, 5) coding all the text, 6) assessing coding consistency, 7) drawing conclusions from the coded data, and 8) proceeding through writing up the findings in a report. We draw conclusions and report our findings in the qualitative content analysis result section (Section 5) later. Here, we mainly explain how we conduct the analysis formally following the first six steps.

Data preparation: As in the statistical analysis, we restricted our sample time window within the same 12-month period: April 2009 – March 2010. In the 8 standard steps of the qualitative content analysis, there are several steps in which the data (e.g. users' posts) need to be read and analyzed iteratively (e.g. developing coding scheme, testing coding scheme,

coding all text). Especially, the steps of development of coding scheme and testing coding scheme are actually iterations of coding sample text, testing inter-coder agreement, revising coding scheme, and coding more sample text.

As qualitative content analysis is a process of manually reading and classifying the data (e.g. users' posts), we randomly sampled subsets of threads from the 12-month time window for different steps. Detailed information can be seen in Table 4. Since all analyzed threads in different steps were all randomly sampled from the same dataset, we believe that such sampling strategy can guarantee that the developed coding scheme and the analysis of coding results are consistent and valid.

Table 4. The number of threads used in different steps of the qualitative content analysis

	"Developing coding scheme" & "Testing coding scheme"	**Coding all text**
Photoshop	250 threads	400 threads
AutoCAD	50 threads	400 threads
Sonar	50 threads	400 threads

Unit of analysis: As one post in a thread comes from one single author and often serves a specific purpose in the process of problem solving, we define an individual post as our unit of analysis.

Developing coding scheme & Testing coding scheme: For the qualitative content analysis, our purposes are twofold: 1) classifying the opening posts that initiated the threads, and 2) capturing the communication patterns of users' conversations in different threads. Therefore, the coding scheme we developed contains two categorizations: one is specifically for the opening posts, and the other is generally for the posts in threads to capture the communication.

Based on grounded theory [48], we developed the categorizations starting with 25 threads from Photoshop, and then gradually expanding to more threads from other two forums. Four researchers, in pairs, had been involved in the process of developing coding scheme. Every time, after two researchers finishing to code 25 threads, the Cohen Kappa value was calculated to test the inter-coder agreement between them. The categorizations of posts were therefore tested, discussed, and revised by the four researchers until the Cohen Kappa values for both pairs of researchers were higher than 0.85. In summary, the finalized version of coding scheme took 250 threads from Photoshop, 50 threads from AutoCAD, and 50 threads from Sonar.

Coding all the text: we recruited 8 objective coders [65], who were not involved in the prior steps of developing coding scheme. All coders have bachelors degree or above, and work or study in computer science or engineering related field. An hour brief introduction was presented to explain the purpose of this thesis and the details of the coding scheme. Each coder then was requested to independently finish a training session with 60 threads (20 threads per forum) given one-day time. After the training session, the 8 coders were paired up and the Cohen Kappa value was calculated for each pair to measure the inter-coder agreement. After that, each pair of coders discussed the inconsistent posts that had been labeled with different categories by them. It was hoped that such training session could help them to familiarize the coding procedure and clear the possible misunderstanding about the coding scheme.

The official coding includes 1200 sampled threads (400 threads in each forum) with 8501 posts in total. Instead of using paper datasheet in the conventional content analysis, we designed a web-based interface using Drupal for coders to read the threads and label different posts based on the coding scheme (Figure 1). Each coder was assigned a coder id and

password to login the website. Their coding results would be automatically uploaded and saved to our database.

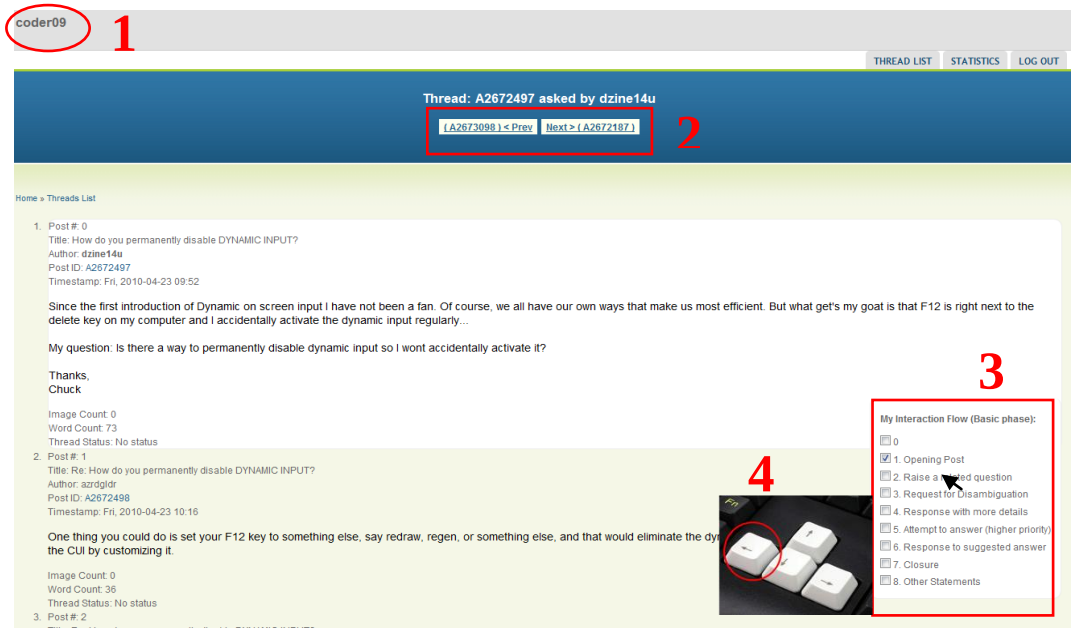

Figure 1. The screenshot of the web-based interface for coders to categorize posts in threads. 1). the coder id. 2). the navigations for the threads that prior/posterior to the current thread. 3). the optional categories for current post. 4) Directional keys on the keyboard: up-and-down keys allowing navigation to different posts in a thread; left-and-right keys navigating different levels of the categorizations.

Assessing coding consistency: The 1200 threads were divided into 24 groups (50 threads per group, 8 groups per forum). Each group was assigned to one pair of coders who independently categorized the posts in these threads. Similar with what we did for the step of generating coding scheme, after a pair of coders finishing one group (50 threads), the Cohen Kappa value was calculated, and then the posts with inconsistent labeled categories were resolved through discussion before the coders moving to the next group. Such discussion aimed at avoiding possible cumulative errors across different groups.

Among the four pairs of coders, the Cohen Kappa values between the two coders in one pair are higher than 0.78 for the categorization of opening posts and higher than 0.81 for the

categorization of posts in communication. Lazar J. stated in his book that a well-accepted interpretation of Cohen Kappa Value in HCI field as "a value above 0.60 indicates a satisfactory reliability" [37], which indicates our coding results exhibit a substantial level of reliability.

3.2.3. User interview

The first two levels of analysis revealed the possible trends or patterns in the generated help content in the three commercial software forums. The third level of analysis will explore the human factor of the forum community and intends to understand the considerations/attitudes while people seek or gave help in the process of solving problems.

Online interview via email: The interview was conducted through email because it facilitates communicating with different community members around the world. Online communication provides the opportunity for interviewees to receive the questionnaires and respond to them at their convenience. It also provides time for them to think about the questions, review and edit their responses [25].

Interviewee: We posted an advertisement on all three forums to seek response from forum users. Within a 2-week time period, we got 18 respondents (5 from Photoshop, 5 from AutoCAD, 8 from Sonar). All interviewees have more than two-year software usage experience and have registered to the forums for more than one year. We admit, comparing against the size of the forum community, 18 forum users are not enough to represent the whole population. However, the interview is meant to triangulate the first two levels of analysis (statistic and qualitative analysis). By gaining first-hand feedback from the 18 users, we hope to provide evidences and rationales behind the prior observed phenomenon.

Questionnaire: All interviewees were asked to complete a questionnaire that contains open-ended questions with regards to their asking and replying experience in the forums. Completing all questions required approximately 45 minutes to one hour.

The questionnaire includes the following three sections. Here, we explain several example questions for each section. The whole questionnaire can be seen in Appendix.

- The general usage and impression about the help forum.
  - E.g. what's the best/worst thing you felt using this forum?
  - E.g. what are your main activities while visiting the forum? (Such as, asking question, replying others, viewing)
- The asking experience in the help forum.
  - E.g. In a typical scenario when you post a question, how long does it take for you to prepare your question description?
  - E.g. In what situation do you feel most difficulty in describing the problems clearly?
- The replying experience in the help forum.
  - E.g. Before you reply to a thread, will you read the previous posts? If you do, what influence such posts made on you in order for you to formulate your own response?
  - E.g. After you post a question, have you ever solved the problems by yourself instead of depending on community help? If you do, will you share the solution with the community via posting a reply to the thread?

Procedure: Before the questionnaire is being sent, an email was sent to each interviewee to briefly introduce the purpose of the interview and to ask for basic demographic information, such as their forum usage history.

During interview, a series of emails were exchanged between the interviewees and the interviewers (e.g. researchers). Each interviewee was asked to finish all the open-ended

questions in the questionnaire and sent the answers back within one week time. During this period, interviewees could contact the researchers through email if they had any troubles/confusion in understanding the questions. After receiving an interviewee's answers, researchers checked the responses and sent emails back to him/her for clarification of possible ambiguities.

Upon completing the questionnaire, each interviewee would receive a $25 Amazon gift certificate for their effort and time.

Data gathering: All exchanged emails between the interviewees and the interviewers were saved as interview data, which was analyzed using affinity diagram [10] to group similar topics and opinions.

Upon introducing the three-level of analysis methods, we now follow up with explaining and discussing the analysis results at each level.

4. Statistical Analysis Result

The statistical analysis paints an overall picture about the dynamics of forums. In particular, we applied the statistical metrics that were defined in previous studies about general-purpose online discussion sites and intent to represent the activity level and characteristics for the three evaluated commercial software forums.

4.1. Activity Level

In regards to the activity level, we examine three statistic metrics: the number of posts per user, the response rate, and the percentage of users who only contributes questions/replies.

Number of posts per user: Table 5 presents the average and standard deviation values for the number of posts per users for three forums. By comparing the average values of the number of posts per user in the three forums, One-way Anova test showed that Sonar users posted the most messages ($F_{(2, 18304)} = 66.792$, $p < .01$).

Table 5. The number of posts per users in three forums (Min, Max, Average and Standard Deviation value)

Forum	Min	Max	Avg.	Std. Deviation
Photoshop	1	5402	6.90	85.91
AutoCAD	1	1700	6.26	37.34
Sonar	1	7141	26.70	159.98

Furthermore, similar to general-purpose online discussion sites, all three forums exhibit a power law relationship between the number of posts per user and the percentage of users with that number of posts. Take Sonar as an example, the most active user in Sonar has posted 7141 messages. But at the same time, more than 90% of Sonar users only posted less than 50 messages (e.g. 91.65%). Figure 2 shows the number of posts per user over the percentage of users for Sonar to represent the power law distribution. (Note, the other two forums followed a similar graph shape)

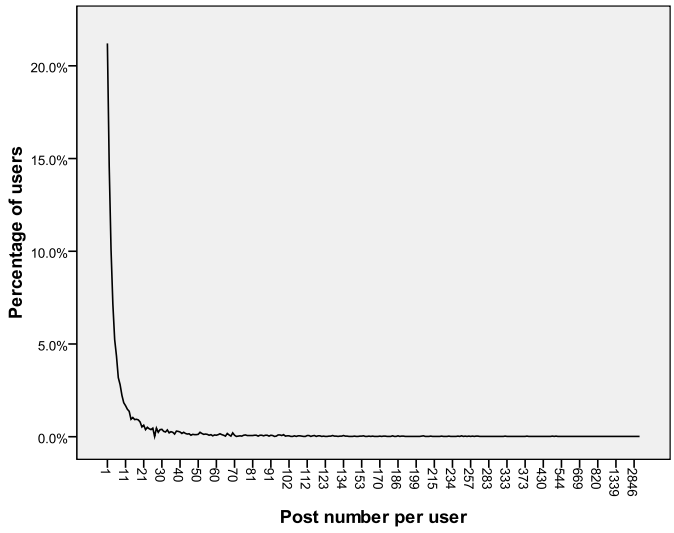

Figure 2. The relations between the number of posts per user and the percentage of users with such post number

Response rate: Response rate for all three forums that have more than 89% of threads gets at least one response, which indicates a relatively low barrier to start a conversation (e.g. 94.4% for Photoshop, 89.18% for AutoCAD, and 89.81% for Sonar). In comparison with previous studies, Usenet got 40% of threads received no replies, while Yahoo! Answer has a range of response rates from 47% to 95% across different categories. This comparison helps to confirm Yarid's statement: "posts making specific requests and serious topics (e.g. seeking help about specific software problems) elicit high response rate" [62].

Percentage of users who contributes only to questions/replies: Nam el al. revealed that there were only 5.4% users in Naver (the largest Q&A site in South Korea) who played the role of both as an asker and replier [29]. We believe that the number of questions/replies a user posts to the forum can help indicate his/her sense of belonging to the community. The results can be seen in Figure 3, which hints that the users in commercial software help forums are more active in contributing to the community (more than 44% of users who post both questions and replies in all three forums).

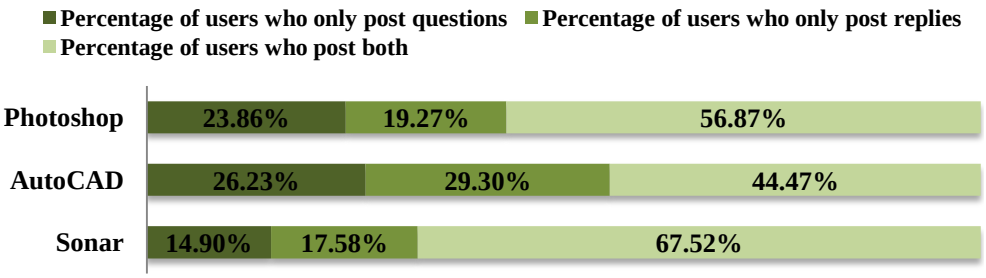

Figure 3. The percentages of users who only post question, only post relies, and post both in the three forums

Comparing the three forums, Sonar users again demonstrated the most positive attitudes in participating to the forum (e.g. the largest percentage of users who played both roles of asker and replier, 67.52%).

4.2. Forum Characteristic

From the above analysis of activity level, it already shows some interesting differences among the three evaluated forums, such as Sonar users are more active with posting questions and replies. As mentioned in the related work section, by observing the different forums in Usenet newsgroup and Yahoo! Answer, it was found that there are some common clusters of forums in these two sites (e.g. technical forums vs. socialization forums). By further characterizing the three forums, we applied the following three statistical metrics to verify whether similar clusters exist in the domain of commercial software help forums.

- *Percentage of users who appeared once*: it was shown that technical newsgroups in Usenet have more users who appeared only once (e.g. 41% - 50%) than socialization/discussion newsgroups have (e.g. 20% - 32%) [51].
- *Number of posts per thread*: it was shown that technical newsgroups/forums in Usenet/Yahoo! Answer have more posts per thread than socialization newsgroups/forums have [33, 51].

- *The overlap of asker and replier*: it was shown that the technical forums in Yahoo! Answer have a higher overlap of asker and replier than socialization forums have [33]. Here, "the overlap of asker and replier" follows Adamic et al.'s definition: the cosine similarity between the number of questions and the number of replies per user [33].

The results for the three evaluated forums regarding the above three statistic metrics can be seen in Table 6.

Table 6. The statistic results regarding different metrics for clustering the three forums

Forum	Percentage of users who appeared once	Num. of posts per thread	The overlap of asker and replier
Photoshop	35.68%	6.54	0.13
AutoCAD	45.83%	5.87	0.20
Sonar	21.49%	10.68	0.34

It shows that the percentage of users who appeared once for AutoCAD (45.83%) falls into the exact range of technical newsgroups in Usenet (41% - 50%), while the value for Sonar (21.49%) also falls into the range of socialization/discussion newsgroups (20% - 32%). Moreover, Sonar has the highest number of posts per thread (10.68) and the largest overlap of asker and replier (0.34). While AutoCAD has the fewest posts per thread (5.87) and a relatively small overlap of asker and replier (0.20).

These observations indicate that, although the three chosen forums served the specific purpose for helping commercial software learning/usage, similar forum characteristics in general-purpose online discussion sites were also observed among them. In particular, Sonar has more social characteristic, while AutoCAD is more technical-driven.

4.3. Summary

To sum up the statistical analysis, it suggests by comparing general-purpose online discussion sites, such as Usenet and Yahoo! Answer, users' activity level in the evaluated commercial

software forums are more responsive (e.g. high response rate, more users who played both roles of asker and replier). It may because the nature of commercial software forums which decides that the discussed issues in such sites are more specific and relates to a particular software application, which elicits more responses.

On the other hand, as being one type of online discussion sites, commercial software forums also exhibit some general trends, such as power law distribution of users' posts, and similar clusters of forums: the social characteristic in Sonar and the technical characteristic in AutoCAD.

With the above analysis, we gather basic quantitative statistic about the dynamic of the three forums. The remaining questions are how the discussed content in these sites are affected 1) by the nature of commercial software forums, and 2) by the different forum characteristics: social or technical? To answer these questions, we continue to conduct the second level of analysis to examine the users' posts from a qualitative perspective.

5. Qualitative Content Analysis Result

The second level of analysis concerns the help content in threads. With qualitative content analysis, the developed coding scheme consists of two categorizations, one for classifying the opening posts, and the other for identifying the roles of different posts in threads for solving problems. By manually coding 1200 sampled threads with 8051 posts, we further discuss the distributions of these categories of posts and relevant implications.

For this thesis, our focus is to know how software communities leverage on forums to communicate software learning/usage experience. Therefore, of the 1200 sampled threads (400 threads per forum), we exclude the ones that are irrelevant with software learning or usage. The issues raised in such excluded threads ranges from discussing sale price or promotional offers, to purely social greeting to other forum users. For further analysis, we only consider the remaining threads relevant with software learning/usage (e.g. 368 threads from Photoshop, 394 threads from AutoCAD, and 359 threads from Sonar).

5.1. Classification of Opening Posts

Previous studies about analyzing the help seeking content in online discussion sites have emphasized two criteria: the question type [59] and the question topic [61]. While developing the categorization for the opening posts in commercial software forums, we considered both criteria and extended with another one as the scope of the opening posts, which captures the affected extents of the raised issues in the posts.

Our categorization for the opening posts thus contains three dimensions: type, topic and scope. In each dimension, several categories are defined. We present the results according to the distribution of the opening posts in different categories (measured in percentage) and the average length of these posts (measured in the number of words per post [33]) in different categories. We regard the length of an opening post as a soft indicator of how complex or

information-rich the raised issue might be. When it comes to the differences among the three forums, we used One-way Anova test to compare the average post length in different categories.

5.1.1. Type of opening posts

For the first dimension (type), we are concerned with the language composition; how the opening post was described. In particular, four different types are identified:

Sharing: The opening post does not ask for help, but starts a discussion by sharing a personal experience, e.g. "*I just found a way to make Notion 3 and Sonar 8 work together. Here is what I did… what do you guys think about it?*"

Error/Stuck: The opening post seeks help regarding a situation that prevents users from carrying out a function or operation, e.g. "*CS5 suddenly stopped working rightly after it opens. Any thoughts?*"

How-To: The opening post seeks help, but it is not about a problem or error encountered within a function or feature. Instead, it inquires about a specific procedure, such as how to finish a certain task or use a specific function, e.g. "*How do I display two images on my monitor simultaneously?*"

Inquiry: The opening post seeks help by asking for information or exploring the functionalities of the application, e.g. "*Is Sonar 8 compatible with XP 64?*"

Figure 4 reveals the distribution (in percentage) and the average length of these different types of opening posts.

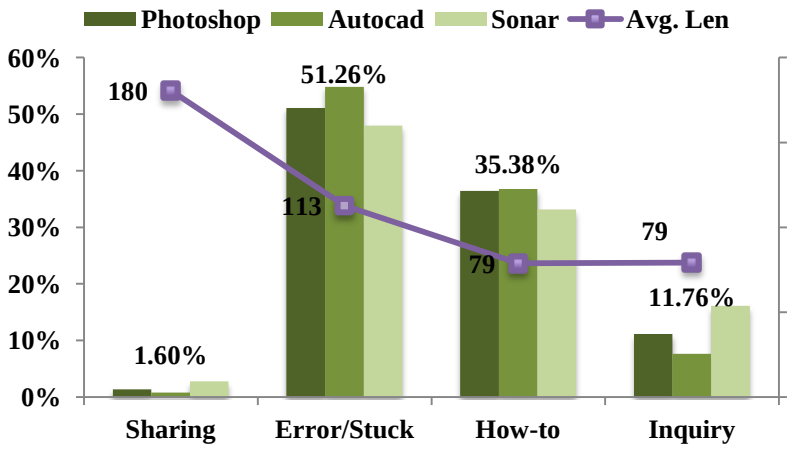

Figure 4. The distribution and the average length (word num.) of opening posts in different types

Overall, it shows that the most common type of opening posts is *Error/Stuck* (51.26%). In Singh et al.'s study about OSS forums, they reported that the most frequent type of questions is how-to (34 out of 80, 42.5%) [59]. Although further confirmation needs to be done, one possible explanation is the community-updated nature of OSS [34] increases the flexibility of the software functions and makes it harder to document all possible situations integrated help manual. This may motivate more *How-to* questions in users' learning/exploring process.

Considering the average length for the different types of opening posts, it suggests that the longest type is *Sharing* ($p < .001$). A sharing opening post normally describes the personal experience or opinions with the intention to start a discussion with other community members. In such posts, users need to explain the step-by-step procedures they have performed, which will invariably lead to more detailed and longer descriptions.

5.1.2. Topic of opening posts

For the second dimension (topic), we are interested at the subjects discussed in the opening posts (e.g. the events that cause the issue to be raised). Four different topics are observed:

Installation: The opening post describes installing or uninstalling issues such as a new version of the application or an upgrade of the system, e.g. "*I attempted to upgrade Photoshop 7.0 to 7.0.1. Suddenly, the upgrade program could not find the installation path.*"

Maintenance: The opening post is about how to configure the application to make it function correctly or perform better, e.g. "*I'm curious how people configure their non-RAID hard drives for Sonar 8.5.*"

Specific Task: The opening post describes a particular task that the user intends to accomplish with the software, e.g. "*I'm creating a simple vector in Photoshop. I was wondering if you could lock the vector mask.*"

General Learning: The opening post inquires about the functionalities of the software, e.g. "*What do you think of the tempo envelope feature?*"

Figure 5 shows the distribution (in percentage) and average post length for these different topics. It can be observed that *Specific Task* has the highest proportion (49.99%). This is somewhat expected, since the primary role of a software application is to help the users to accomplish certain task.

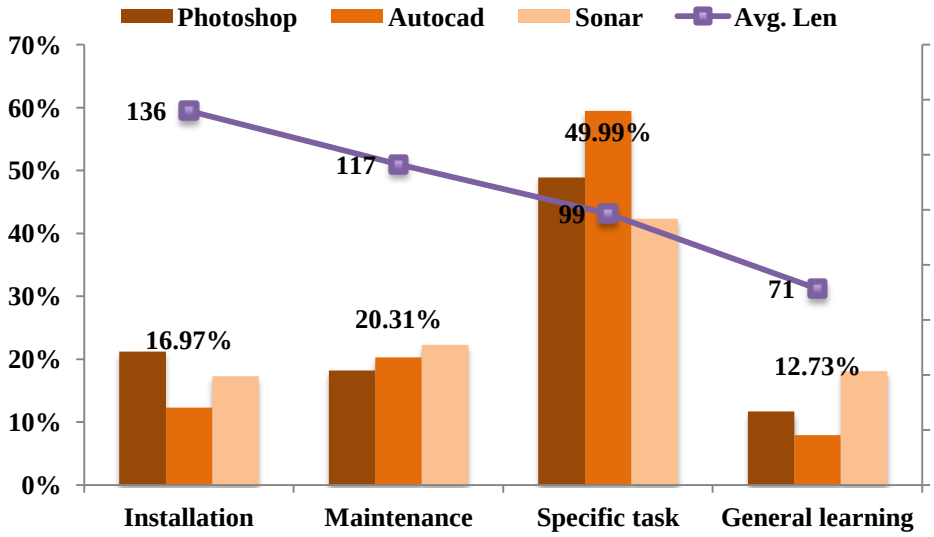

Figure 5. The distribution and the average length (word num.) of the opening posts in different topics

On the other hand, installation is only an initial step for the user to use the trial or product; and commercial software products typically undergo stringent installation testing [5] before it is released. Therefore, it is somehow unexpected that the topic of *Installation* happens quite often (e.g. 16.97%) in these opening posts. Moreover, the analysis of the length of posts also shows that the opening posts with the *Installation* topic cost the most words on average ($p < .05$). Possibly when error occurred during installation, users typically are unable to hazard a guess of the problem's nature, they thus attach any possible relevant descriptions with the hope that other forum members can help identify possible causes and hence suggest solutions.

5.1.3. Scope of opening posts

For the third dimension (scope), we capture the extent of that the raised software issues may affect (e.g. strictly within the application or beyond it). We categorize four levels of different scopes:

Intra-Application: The scope of the opening post is limited to the application itself, e.g. "*In the history panel of Photoshop, how can I set the source for the history brush?*"

Cross-Application: The scope of the opening post involves other software applications, e.g. "*Does Notion 3 (another application) run smoothly with Sonar?*"

Operating System: The scope of the opening post involves operating systems, e.g. "*How good is Sonar 8.5 on Windows 7?*"

Hardware: The scope of the opening post involves specific hardware, such as graphic cards or scanners, e.g. "*After I installed a new tablet, Photoshop could no longer detect my graphics card.*"

By categorizing the scope of opening posts, we are only concern with the content of the posts itself rather than the possible causes. For example, an opening post with the description "*my application crashed suddenly*" is classified as the scope of *Intra-Application*, although the reason for such crash might be at system level (*Operating System*). Figure 6 presents the distribution (in percentage) and the average length of the opening posts in different scopes.

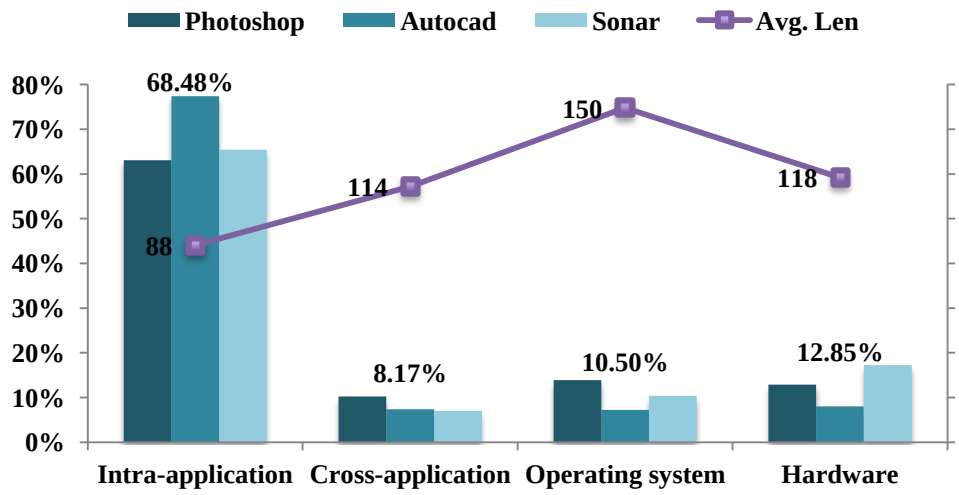

Figure 6. The distribution and average length (word num.) of the opening posts in different scopes

Overall, it shows the majority is about functions and features within the application (*Intra-Application*, 68.48%), which is not surprising since such forums are places meant for users to discuss the specific application.

However, a significant number of opening posts are actually related to the compatibility issues (the other three scopes), which suggests that the usability of software usually cannot be determined by its features and functions alone. More interestingly, such compatibility issues, especially with *Operating System*, normally indicate a consideration or even potential threat why customers hesitate to purchase the product, which should attract more attention from the development company.

Further analysis of the length factor reveals that opening posts that relates to operating system are the most verbose ($p < .01$). This is possibly because that a problem under the topic of *Operating System* often suggests a circumstance that is urgent and needed to be solved; users may consider such problem as more critical and attempt to provide all relevant information to attract replies. From the following example, it can be seen how hard a user may try to state or solve a problem related to the operating system, "*I've been pulling my hair out recently trying to get everything to work out. About three or four weeks ago, I went to import a track into a project and Sonar locked up. I did a hard boot and received an ominous BSOD. Windows never opened after that and it couldn't read the C drive… Then I tried to reinstall my system… for a week, everything seemed fine. Then I noticed a number of strange issues…when I opened a previous project, Sonar has no response… When I click the Start button… When I tried to copy a file from one folder to another… I really don't know what to do now. It is definitely not the reason I spent hundreds dollars for!*"

5.1.4. Summary

By identifying the three dimensions (type, topic, and scope) for characterizing different opening posts, we are able to get an overview of the typically discussed problems in the commercial software help forums.

From the above results, it can be observed that the most common opening posts are of type: *Error/Stuck*, of topic: *Specific Task*, of scope: *Intra-Application*. This suggests that users are most likely to start a thread in the forums when they are either stuck in a procedure or encountered an error while executing a particular task. With this knowledge, future help tool for software should devote more effort in monitoring possible error events and automatically provide application-level context.

Furthermore, the most verbose case is found to be of type: *Sharing*, of topic: *Installation*, of scope: *Operating System*. In particular, the longest opening post in our sample has 3,913 words where the poster shared his/her configuration strategy to optimize the performance of Sonar upon the operating system: Windows 7. Considering the significant amount of effort a user needs to put in composing such a lengthy post (organizing thousands of words), this certainly illustrates an opportunity for future help tool to reduce the users' workload when describing such details. For example, recording the user's operation sequence at system level and providing a visualized context collectively with the user's self-description can largely ease the process of Sharing.

5.2. Investigation of Communication

With the above analysis, we have shown that the opening posts in commercial software forums are quite diverse with different types, topics, and scopes. A natural follow-up question is, with these various opening posts, how software users communicate in the threads to discuss/solve such raised problems?

5.2.1. Communication category

Through the qualitative content analysis, our second categorization attempts to identify the roles of different posts in the threads in the process of solving the raised problems.

Previous studies about analyzing the help giving content in online discussion sites suggested two possible criteria for classifying different users' posts: the content of one single post and the roles authors played. While developing our categories, we considered both criteria to capture the flow of communication. Five categories of posts emerged and the definitions and examples for these categories are revealed in Table 7.

The first category, *Problem Definition (**PD**),* is the description of the encountered problem that can either be posted by an asker as the opening post that initiates the whole thread, or be raised as a related question by other repliers. At times, the problem description may be insufficient to make a conclusive reply, subsequent *Problem Evolution (**PE**)* posts may occur, where repliers request for clarification in ambiguity and the original asker responds with more details.

The third category is *Suggestion Evolution (**SE**)*. In this stage, it is often marked with the exchange of posts between the repliers and asker in an attempt to solve the problem by trying out various suggestions. Lastly, if a satisfactory answer emerges, the asker then acknowledges that the problem has been solved after which the thread then arrives at the fourth category: *Problem Closure (**C**).*

In contrast to the above four categories of posts which aim at pushing the communication forward and solving a problem, the rest posts are more socio-emotional in nature (e.g., "long time no see"). Since our focus is the problem solving process, we do not further classify such posts and collectively call them as *Discussion/Socialization (**DS**)* posts.

Table 7. The categorization of the posts and representative examples

Content of Post		**Role of Authors**	**Representative Example**
Category	**Sub-category**		
1. Problem definition (*PD*)	Opening post	Asker	*"Please help, I met a problem doing…"*
	Raise a related question	Replier	*"I have a similar question, but my case is…"*
2. Problem evolution (*PE*)	Request for disambiguation	Replier	*"What's your system version?"*
	Response with more details	Asker	*"My system is Win7."*
	Post new findings		*"I just Google my problem. Here is the updated description…"*
	Evidence	Replier	*"I have the same problem"*
3. Suggestion evolution (*SE*)	Attempt to answer	Replier	*"You can try to do…"*
	Response to suggested answer	Asker	*"What's next?"* *"The suggestion didn't work"*
4. Problem Closure (*C*)	Closure	Asker	*"Thanks. It works."*
5. Discussion/Socialization (*DS*)		Both	*"Long time no see"*

5.2.2. Communication pattern

With the above categories defined, we first focus on the first four categories that directly related to the problem solving process and attempt to find out how posts in a thread progress from one category to another.

Six different communication patterns within the threads are identified and labeled from **CP1** to **CP6** (Table 8). Each communication pattern describes a particular type of threads, which are distinct by the flow of the four categories of posts within these threads. For example, CP2: "PD → PE (→C)" represents the threads that start with a *problem definition*

(PD) post, followed by one or many *problem evolution* (PE) posts, then followed by an optional *problem closure* (C) post.

Table 8. The six communication patterns

CP1: PD (→ C)	**CP2**: PD → PE (→ C)
CP3: PD → SE (→ C)	**CP4**: PD → PE&SE (→ C)
CP5: Without PD	**CP6**: Multiple PDs

Note that the first four patterns (CP1 – CP4) all contain two different situations, which go through almost the same path. The only difference between such two situations is that one ends with a closure while the other does not (e.g. In CP1: PD vs. PD → C). The last two communication patterns (CP5 & CP6) are special cases which we will explain the details later.

Figure 7 illustrates the distribution of the six communication patterns (in percentage); and for the first four communication patterns (CP1 – CP4), it also shows the percentage of threads with closure in that pattern (e.g. the second situation). Note that the shown percentage of threads in each pattern is averaged among all three forums. Overall, it shows that the relative distributions of different communication patterns seem to be similar across the three examined forums.

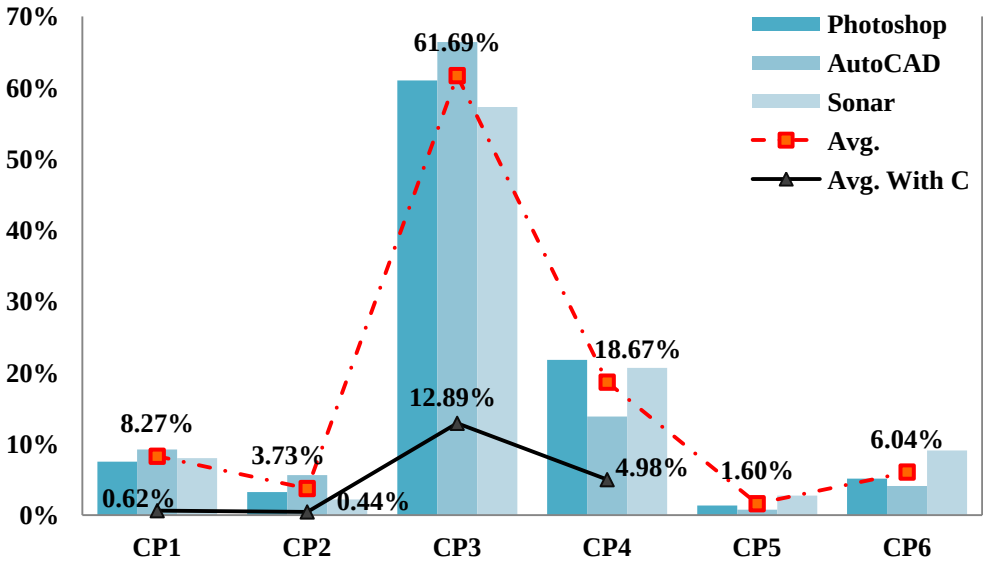

Figure 7. The distribution of six communication patterns (CPs) in three forums. The dotted red line shows the average percentage of threads in each pattern. The solid black line shows the average percentage of threads in the first four patterns with problem closure (C).

We now discuss the six communication patterns and their implications in detail:

Question without repliers, PD (→C): The first pattern is for threads that received no replies from other forum members (8.27%). The first situation is without C (problem closure), which are for threads that only have opening posts. As mentioned in the statistical analysis section, such cases are rare in commercial software forums (7.65%), which can be explained by Yardi's statement "specific requests and serious topics (e.g. particular application learning/usage) can elicit high probability to get reply".

The other situation in this pattern is with problem closure (C) and for threads in which the asker himself posted the solution and closed his own thread. Although such situation doesn't happen quite often (0.62%), this observation provides an evidence to show that users may try other help channels, such as Google search, even after posting in forums. Considering the cost of posting in forums (e.g. switching from the application to the website, collect relevant information and organizing the text), it is highly possible that seeking help from forums may

not be their first choice. In the opening posts analysis, it was also found that the most frequent case for users to post is getting stuck or encountering an error. Whether there is a general help-seeking strategy for users, such as the precedence of all possible help channels, it is an interesting topic worth further study.

Question with clarification only, PD → PE (→C): The second pattern involves threads that receive requests for clarification, but without any suggestions proposed (3.73%). An interesting issue about such threads is, after getting PE posts, why are there are no follow up SE posts? Further checks on such threads reveals that 41.04% of them have only "request for disambiguation" from repliers, but no "response with more details" from the original asker, which implies that the repliers' are confused about the question description and didn't manage to clarify the asker. Thus, it stopped them from continually proposing suggestions.

Moreover, in this pattern, there are 0.44% of threads that closed without any suggestions. It implies that the process of clarifying questions can help to eliminate potential incorrect operations, and therefore revealing possible solution. For example, (**PD**): "*all of a sudden, all my fonts are not working… whenever I try to type something out it is just a black underscore line.*" (**PE**): "*Quick question, how did you set the color of your text and its background?*" (**C**): "*Oh, my god! I feel like such an idiot. I should set them at the same color. Problem solved! Thanks.*"

Question with suggestion only, PD → SE (→C): The third pattern is the most common case, which appears in the form of one problem definition (PD) plus one or several suggestion evolution posts (SE) (61.69%). By further calculating the number of posts under the category of SE, it shows that, each thread has 3.54 SE posts on average. However, among these threads, only 20.89% of them got closed eventually (e.g. 12.89% out of 61.69%). This indicates that

future readers who will experience similar circumstance would need to sieve through all possible suggestions in such threads without knowing whether or not there is a solution.

As there are plenty of suggestions proposed, the question is why is the closure rate for such threads still relatively low? The possible explanation can either be that the quality of the proposed suggestions is not promising, or the askers are too lazy to confirm after getting their answers. From the forum designers' point of view, these observations raise considerations on how to improve the inefficient situations like this. For example, it can leverage the community to weigh different suggestions, such as allowing the forum moderators or other forum members who experienced similar trouble to rate the quality of different suggestions. In this case, even without the askers' confirmation, future readers can also benefit from these suggestions based on the strength of the community.

Question with clarification & suggestion, PD → PE & SE (→C): The fourth pattern is the second most common case (18.67%) with all four categories of posts in the threads.

An interesting observation about this pattern is the order of PE and SE posts. In particular, as a problem is described, the forum users would typically request to clarify the meaning of the description first or directly provide their suggestions. Our results show that the occurrence of SE post appearing before PE posts is at 55.70%, higher than the opposite process (44.30%) (E.g. SE → PE is more than PE → SE).

Considering the nature of online help forums, this phenomenon can be explained from two aspects. First, the asynchronous posting manner introduces inevitable delay when a replier requests for disambiguation about the problem descriptions. Therefore, from the users' point of view, they probably prefer to state their suggestions directly instead of waiting for the askers' further clarifications. Second, the restricted textual expression brings up ambiguities for understanding the posts. Repliers thus may misinterpret the question without knowing it.

Sharing, without PD: The fifth pattern is one special case whereby the threads do not start with problem descriptions but statements (1.60%). The opening posts of such threads have the type Sharing. It means that there is no problem that needs to be solved. Instead, the primary purpose of the user who initiated the thread is to start a discussion with other forum members. Therefore, we labeled all follow-up posts in such threads with the category of "Discussion/Socialization".

By further looking into these threads, it was found that there are two different cases of Sharing: 1) Sharing techniques or information (e.g. *"I found a fantastic website for Photoshop tutorial. Here is the link…"*). 2) Sharing opinions or comments (e.g. *"Just tried Sonar 8.5. I noticed they changed the locations of some tools… My feeling about such changes is not good…"*). The first case enriches the knowledge base of the forum, which can benefit other users, while the second case reflects users' feedback about the products, which can benefit software designers. It shows that such Sharing threads play an important role in the software forums, which should be motivated more in the future.

Multiple conversations, Multiple PDs: The last pattern is another special case, in which more than one question from different users is raised (6.04%, Number of PD > 1). In such instances, the progression of posts is often complicated and involves multiple conversations happening in the same thread. Posts responding to one question would tend to interleave with posts answering another.

For the forum designers' point of view, it indicates the necessity to distinguish different conversations within the same thread. For example, differentiating the background color of posts or allowing users to create customized tags for their posts. Additionally, future study can investigate how different conversations will influence each other when solving related but different questions.

5.2.3. Summary

From the above analysis, we identify the users' communication patterns and their relative distributions in the collaborative problem solving process, which turns out to be common across the three evaluated forums.

Our results show that, for askers who raised questions in the forums, there are different ways for them to get help (e.g. through the process of problem clarification to recall what they did wrong or directly through the proposed suggestions). On the other hand, these askers also reward the community through different ways (e.g. finding solutions through other help channels and getting back to the threads, or starting a sharing thread to enrich the knowledge base). Furthermore, the occurrences of these identified communication patterns also raised some design concerns for forum designers: 1) motivating more active participations from the askers (e.g. responding to repliers, returning and sharing solutions); 2) using the collective knowledge of the community to weight the quality of different suggestions; 3) distinguishing multiple conversations in the same thread, for example, enhancing the visualization of posts with different purposes.

5.3. Influence of Forum Characteristic

With the above analysis about opening posts and communication patterns, we have investigated the generated help content from the community and summarized the common trends that existed across all three forums. Now, we discuss the differences among these three forums and attempt to reveal the influence of the different characteristics of forums (e.g. Sonar users have more social behavior, while AutoCAD users focus more on discussing technical issue).

Regarding the types and topics of the opening posts, it shows that Sonar has the most opening posts of "*Sharing*" and "*General Learning*", while AutoCAD has the most cases with

"*Error/Stuck*" situation and relates to accomplishing "*Specific Task*". Furthermore, the identified communication patterns further shows that Sonar has the highest percentage of threads with multiple conversations (CP6), while AutoCAD has the highest percentage of threads with question followed by suggestions only (CP3).

The above phenomenon suggests that, with social characteristic, Sonar is more likely to attract irregular conversations (e.g. multiple conversations in single thread) and to establish relationship among forum members. Therefore, Sonar users have higher responsibility to the community as they actively share more personal experience. On the other hand, with technical characteristic, AutoCAD focuses more on solving specific software problems (e.g. threads with suggestions only). Thus the users are more problem-driven and more likely to turn to the forum for troubleshooting.

In our categorization of classifying the roles of different posts in the communication, the fifth category of Discussion/Socialization captures the users' social behavior. Figure 8 illustrates the average number of posts in different categories at the level of threads across three forums. Overall, it can be seen that Sonar has a larger number of posts per thread which is mostly due to an increase in the number of both SE and DS posts. Additionally, AutoCAD has the least DS posts, which verifies again its technical characteristic.

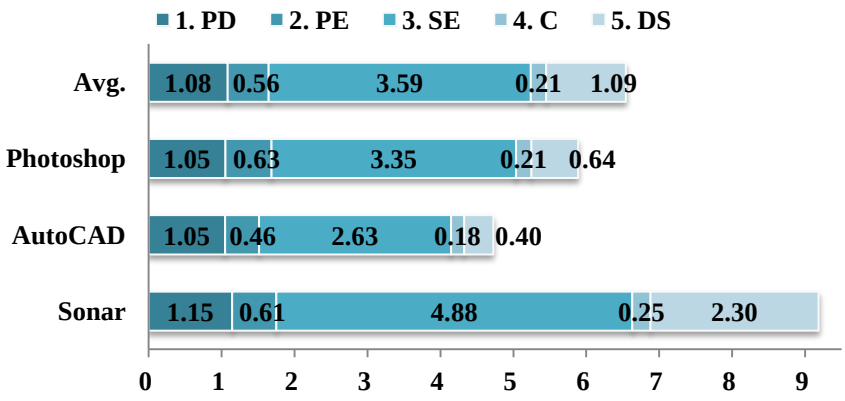

Figure 8. The average number of different categories of posts per thread for three forums

To further examine the influence of the users' social behavior, we applied Pearson correlation test [50] to examine the correlation between Discussion/Socialization (DS) posts and the other four categories of posts in threads (PD, PE, SE, and C. The results show that there exists a positive correlation between SE posts and DS posts ($r_{(1121)} = .31$, $p < .01$). Additionally, Figure 8 also tells us that Sonar has the highest probability to get closed (25%) while AutoCAD has the lowest (18%). All these evidences hint that building social relationship is likely to promote collaboration among users to propose suggestions and solve a problem.

However, considering the viewing experience for general readers, such social behavior can also be a distracter for them to locate useful information (e.g. correct answer). From the forum designers' point of view, this raises an interesting design tradeoff between encouraging more social behavior and minimizing their distractions for general readers.

6. User Interview Result

The first two levels of analysis have studied the users' posts in commercial software forums from a quantitative and qualitative perspective. The third level of analysis focuses on the forum users themselves and intends to reveal their thoughts behind online posting activities.

We summarize our interview results from the users' point of view in three aspects: 1) the considerations for formulating a post; 2) the attitudes about the help gained from the forum community; 3) the attitudes about rewarding the community.

6.1. Consideration for Post Formulation

After deciding to post a message to seek help from the forum, users normally need to prepare/collect relevant information and formulate the post. The analysis of opening posts already told us that there are verbose cases that take much more effort, especially when it relates to the operating system.

Our interview results also confirm that the preparation time varies from different users and the complexity of the problem context. It was claimed that writing a question typically took less than half an hour. But in some extreme cases, it might take several hours and up to day to prepare a question. We review three considerations that might lengthen the preparation time for post formulation:

Eliminating irrelevant response: The primary purpose for users to seek help in forums is to get their problem solved. It is believed that "*filtering out extraneous observations and forming a question with anticipating the possible responses would improves the likelihood of getting a relevant answer*". Additionally, users also care about their reputation in the community, especially for experienced users, as cited from a Sonar user, "*I would like to take time to read back my post to make sure it is clear and there are no spelling mistakes. Careless posts are easier to be ignored and will damage my reputation*".

Collecting all relevant information: One reason why proper question structuring is not easy is because the poster needs to collect relevant information. All interviewees (18/18) agreed that specific context (e.g. "*breaking down the steps that have been taken*" or "*the detail information about task background and procedure*") is very important to make others understand your requests/intentions. In particular, this process of "*recording the steps to validate the problem, including preparing the screenshot*" can help other forum members to "*realize what I have been doing wrongly and I thus solved the problem myself*". However, in some special cases, it is not an easy task for the users to decide what information is relevant or not. For example, when "*system crashed*", it is just not as easy to "*reproduce the whole circumstance*" and "*had no idea what caused the problem*".

Trade-off between details and readability: To create a good question description, one facet is to provide all relevant information in order to make it possible for others to help, the other facet is making the explanation straightforward to let others would like to take time and read the provided details. It was reported that one of the reasons that prevent repliers to respond is "*too wordy*" question description. It seems that there exists a trade-off between details provided and readability. Considering the diverse users' background in the forum community, "*not everyone in the forum uses the same terminology*". One expert user from Sonar mentioned that, "*when I post a question, it's usually a pretty complicated issue. So it takes longer time to figure out the proper context and to tailor my question to the average level of expertise to attract more possible answers*".

6.2. Attitude about the Community Help

After posting an opening post to the forum, a user can get help from the community in both the process of question clarification and the process of possible suggestion discussion.

Regarding the users' attitudes about the help they have gotten from the forum community, we summarize three aspects:

Unsatisfied technical support: It was reported that software users treat online help forums as one of the help channels that they may turn to. Normally, it is not their first option. When encountering a problem while using software, most of interviewees would do self-trial and error first (16/18). Even after posting to the forum, they won't purely rely on possible incoming replies, but continually try other help channels, such as Google search, simultaneously.

While commenting on the technical support provided by current forums, all interviewees (18/18) seem to be negative. Compared with Google search, the built-in search mechanism in the help forums is "*clunky*" and always "*threw up irrelevant things*". It is a concern that the forums don't perform a thorough search that contains all achieved posted threads. Especially, "*without keywords*" for each thread/post which increases the workload for users to scan to quickly "*get the main point*".

Benefit from diverse user background: all interviewees (18/18) mentioned that "*learning something new and seek alternative opinions*" is one of the purposes of using the forums. As the help community has "*broad experience representing diverse areas*", users can benefit from it by seeing different views about the same topic or learning a feature from others' as an alternative which they haven't considered before.

Especially for experienced users who does not encounter issues frequently, the main benefit from the forum is the "*level of knowledge*" offered by the helpful community that has "*broad experience representing diverse areas*".

Tolerant of the quality of response: In regards to the quality of the received responses, unlike the negative feedback about forum technical support, the interviewees are generally

tolerant of the quality of replies as long as the posters showed sincere attitudes. It was claimed that users understood that the help given by the community is on a voluntary basis and "*you cannot require anyone has the same expertise level as an expert does*". And as an asker, they are normally open to any response as long as the replier offered "*earnest and well intentional help*", even if "*they don't have the answer I am looking for*". This finding is consistent with Joyce's work about users' motivations in general-purpose online discussion sites: "the quality of replies doesn't affect the users' continual posting" [17].

6.3. Attitude about Rewarding to Community

In addition to getting help from the forums, users also reward forums via finding solutions through other help channels and replying back to the threads. We reveal the users' attitudes about rewarding the community with three motivations:

Enriching knowledge base: The primary motivation for users to return and share the found solutions is to benefit other users who may experience similar problem. Additionally, by describing their own solutions, the user hopes to encourage other forum users to follow the same rule. One interviewee state, "*Every time I shared my solution, I would make a point to encourage other to share theirs as well.*"

Attracting workaround: Learning diverse views about a single topic is one of the purposes that forum users have. Through clarifying their own solutions, the users intend to attract others to "*provide possible workarounds*". As one interviewee said, "*My solution might not be the best one to solve the problem. I would still come back to the thread and check whether there is an alternative proposed*".

Logging for future reference: It is revealed that software users don't only treat online help forums as a place to discuss and communicate software leaning experience, but also as an online resource for future reference. by posting solutions in their own threads, the users

consider it as an online record of what they have went through and what they have done, as cited from one interviewee, "*I always shared all the steps I performed and posted them online, in case I want to look back later, or the same problem happened again*".

Furthermore, the complexity of describing the solution may hinder the users from sharing. One interviewee stated, "*Sometimes I didn't keep capturing my screenshot when solving the problem. It is very tedious for me to recreate all the circumstance when I finish everything, especially for complicated problems*". This suggests that, to motivate more self-closure in forums, recording and visualizing the users' operation history is a necessary factor that needs to be considered.

7. Discussion & Implication

From the above mix-level analysis, we have investigated commercial software forums from three different aspects: the forum dynamic, the content of posts in threads, and the users' attitudes in the process of solving problems. Based on our analysis results, we now discuss the insights and possible contributions for different audiences.

Benefits for Software Development Company: The classification of the opening posts has characterized users' questions based on three dimensions (type, topic and scope), which provides a new perspective to examine users' feedback about the software products.

For example, an opening post, which has the type of *How-to*, the topic of *Specific Task*, and the scope of *Cross-Application*, normally indicates the user's expectation regarding a desired but unimplemented software feature. E.g. "*I was playing with Premiere (Cross-Application). I like its white balance feature. I want to create a picture for my personal website (Specific Task). How can I achieve a similar effect using Photoshop (How-To)?*" By summarizing the users' expectations from such posts, it can help to develop the users' wish list of their expected features. For Software Development Company, analyzing trending topics and implementing relevant features can enhance the competitive power of its software products and therefore attract potential customers.

Another useful example is when the opening post is of the type: *Error/Stuck*, the topic of *Installation*, and the scope of *Operating System*. Such question usually has severe priority, as installation is the initial step of the usage of the software and the affected extent of the problem has expanded to the operating system. E.g. "*I just switched my system from Vista to the Windows 7. I used to like to use CS4 for my photo editing. Now I am considering updating to the new version of Photoshop CS5. As running the setup.exe* (*Installation*)*, suddenly out of nowhere, I got a BSOD-blue screen of death (Error/Stuck). After that, I reboot my system.*

Somehow all the installed programs seem gone. I saw an empty list from the Start menu (Operating System)…"

Such posts typically reflect compatibility problems between the software and the operating system. *Error/stuck* emerging in such situations thus might be a big concern for users to decide whether to continue using the product or not. Summarizing the raised issues in such posts and providing the corresponding step-by-step instructions in the help manual can better stabilize the products and conserve current customers.

Reference point for Software Learning Researcher: The investigation about users' communication has classified different threads into six communication patterns. It shows that more than 55% threads get all replies discussing possible suggestions (SE posts only). But such process of suggestion evolution seems not efficient in terms of the problem solving (E.g. 20.89% of them closed). However, as the threads get to enter the process of clearing the possible question ambiguity (PE posts), the probability for such threads to close from proposed suggestions increases as well (E.g. CP4, questions with both clarification & suggestion, 26.68% of such threads closed). These observations suggest the importance of the posts for the question clarification. However, current circumstance is software users seem undervalue the process of question clarification and prefer to describe their suggestions directly (e.g. SE → PE happens more than PE → SE).

A future research direction can be how to realize the users' desire about question clarification. Previous researchers have investigated different methods to elicit active help from forum members, such as scoring a user's expertise level based on the average rating of his/her suggestion quality from the community. Our results implicate the possibility to evaluate a user's help power based on the content of his/her posts. For example, rating a user's trusty/responsibility level based on the ratio of his/her SE and PE posts, in which case,

if a user's posts are purely for describing suggestions (SE) but no PE posts at all, it may hint his/her impatient attitude while trying to read/understand others' question descriptions.

Furthermore, the revealed communication patterns and their relative distributions can be used as an important point of reference to help evaluate future design of community-based software help tool. By reference point, we meant patterns and statistics which we have provided can be used by future studies to perform cross-study comparisons. The nature of community-based software help tool is the generated help content that is from the whole community. Therefore, it's not always possible to perform a before-and-after study on any new design of software help tool due to practical limitations. Future researchers can analyze the corresponding communication patterns and their distribution of a new software help tool and compare the data with ours (i.e., whether a new design feature helps to trigger new communication patterns or to change the original distributions).

Suggestions for Software Forum Designer: Based on our analysis and user interview results, it shows that current forum design is not efficient in terms of facilitating the process of software learning/usage. For example, the closure rate of threads is not high (21%), the repeated restatement about the question description (PE posts). Considering these inefficiencies, we summarize three considerations for software forum designers:

- Color the backgrounds of posts to distinguish different posts with various conversation purposes:

  By classifying the different posts in threads, it is clear that they all serve different purposes of communication. In particular, there is a distinction between the posts for establishing social relationship among different forum members (DS posts) and posts for pushing forward the problem solving process (e.g. PE and SE posts). Moreover, CP6 further reveals the possibility of multiple conversations in one single thread, which results

in a distinction between the posts for helping the opening questions and the posts for helping the branched questions.

By introducing different color backgrounds for posts with varied conversional purposes, it can provide a visualized impression for the askers and general readers to quickly capture the flow of communication.

- Log and visualize users' operation sequence to ease the procedure of post formulation:

  The analysis of length for opening posts has indicated the difficulties faced by the users to describe their questions, especially during *Error/Stuck* situations at the level of *Operating System*. Furthermore, from the user's interview results, it is also discovered that one reason that may stop a user from rewarding the community with his/her solution is the complexity of describing it. Designing an monitoring tool, which integrates with the application to log and visualize the users' operation sequence, can help to ease the post formulation in both situations, such as Chronicle that helps users share their workflow histories [57].

- Allow customized keywords/tags for threads and posts to manage the social behavior:

  As mentioned in previous section, there exists a trade-off between motivating more social behavior and managing the along with distractions for general readers. Allowing users add keywords or tags for different threads and posts could be a good way for serving both purposes. On one hand, to encourage more social connection, with personal tags for threads and posts, forum members can customize subscription or notification mechanism to particular threads or posts. In this case, users can specify what topics or what type of threads they are interested in and would like to join for conversation. On the

other hand, to manage the social distracters, general readers who read threads with the purpose of information seeking can filter out such social posts easily based on their tags.

8. Conclusion

In this thesis, we have performed what we believe to be the first thorough analysis of commercial software online help forums. We target 3 commercial applications which all host active forum posting activities and have varied sizes of user community. Our methodology include a statistical overview of the forums, a detailed qualitative analysis of the opening posts and the communication patterns occurring within individual threads, and a 18-user online interview to further understand these three forums from the user's perspective. This combination of methodologies allows us to shed new and important light on the current usage, benefits, and challenges related to community-based software help forums, and allows us to discuss design implications for software developers and researchers. We believe that community-based help will continue to grow in the future, due to the wealth of knowledge it can provide, and the low-maintenance cost which it requires. As such, we feel our results will be an important resource for future implementations and research in improving the software learn-ability.

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Appendix

For the appendix, we attach the questionnaire for our online user interview.

Background Information:

1. How long have you been using XXX?
2. What is your expertise in using XXX?
3. How long have you been registered in this forum?
4. How frequently do you visit this forum?

Forum Experience:

The following questions are about your overall impression about the forum.

1. Please describe the last 3 problems you encountered when using XXX forum, and how did you resolve them?
2. Do you have an overall strategy for solving problems? Is it dependent on the type/nature of the problem?
3. For each of the following approaches for solving problems,
    a. Trial and error with the software
    b. Ask a friend/colleague
    c. Use software's official help and documentation
    d. Search for answer online
    e. Ask a question on an online forum

    Please state: (**Hint**: You can try to rate those approaches first, then state the situation in details.)

    i. How often do you use this approach?

ii. In what situation will you resort to that particular approach?

4. What's your overall opinion about this discussion forum for XXX? **E.g.** What's the best thing about that and what's the worst thing?
5. What's the main motivation for you to visit the forum? [**Asking, replying (participating), or viewing**]. Please describe how often you carry out each of the following activities on the forum, and what typically motivates you to carry each out: (**Hint**: You can try to rate those options first.)
    a. Posting questions in the forum?
    b. Responding to someone else's questions?
    c. Viewing existing threads (not those you have contributed to) on the forum?

Asking Experience:

The following questions are about your experiences asking questions on the forum.

While posting a question:

1. **In a typical scenario where** you post a question, how long does it take for you to prepare your question description?
    a) In what situation do you feel most difficulty in describing the problems clearly?
    b) When you encounter a problem, is it possible that you will not post that particular question for help in the forum? Can you give us **two reasons** why you would choose not to post a question?
2. When you post a question, please state how often you perform the following activities. How long would it take for you to perform them? How useful do you think these information will help the responders in giving better (or more constructive) answers?
    a) Provide system information

b) Provide specific details about your task

c) Attach a screenshot

d) Attach a video

3. What other challenge you have faced when you post a question?
4. Are there any changes to the forum that you think would increase your willingness to post a question?

After posting a question:

1. After posting the question, do you ever not come back to check your own thread
   a) If so, explain why.
2. **In a typical scenario**, besides waiting for an answer to be posted in the thread, do you try to other different possible approaches to try to solve the problem?

For the possible responses you have gotten:

3. How long do you expect the thread you posted to get its first response? Are you satisfied with the waiting time pertaining to this issue?
4. On an average, please rate your satisfaction of the type of responses you receive from the forum [1-lowest, to 10-highest]. Can you try to describe your feelings about others' response to your question? (**Hint**: Do you find it easy or difficult? Simple, tedious, etc.?)
5. How often do you have to reply to responders to clarify (or elaborate) their answer? What is the reason for having to do this? How does this impact your feelings or experiences from using the forum?
6. Have you ever solved a problem by your own research after posting the question? Will you come back for possible alternative solutions even after the problem solved? [For instance, to share your solution with others or other reasons].

Please try to describe the last question you posted, and the experience you had, in relation to all the above questions.

Replying Experience:

The following questions are about your experiences replying others' questions on the forum.

1. What is your main motivation to replying to other user's questions?
2. How do you describe your experience in helping others to solve their problems?
    a) In what cases you will reply to someone else's post?
    b) In what situations you will not respond to someone else's post? (**Hints**: Try to provide 3-5 reasons that you would or would not response)
    c) Will the tone of the question affect your decision to post a response?
    d) Are there any changes to the forum that you think would increase your willingness to reply?
3. When you feel that the question is not specific enough, will you ask for more details or you will just disregard the question?
    a) How often do you have to ask to clarify the poster's question?
    b) In what cases do you have to do this?
    c) How does this impact your feelings or experiences with using the discussion board?

4. **Before** you post your response, will you read the previous posts?
    a) If you will:

        In general, how do you feel about the responses in the rest of the thread, which are from other posters?

Do you think the previous posts will affect the way you answer your posts in any way?

i. If it affects the way your answer is formed: Can you try to describe the effect on your answer?

b) If you won't, can you tell us why you choose not to read others posts and post your own comments directly?

5. **While** posting a response, how long does it take you to prepare your question?
6. While you posting a response, please state how often you perform the following activities. How long does it take you to perform them? How do you think these would help the responders? If you do not carry them out, state why.
   a) Attaching a screenshot
   b) Attaching a video
   c) Check the solution is correct by replicating the problem and/or solution on your own system
7. When you decide to respond to one thread, are you confident of your response? Will you double check whether your answer works before you post?
   a) If yes, how do you check your answer and why?
   b) If no, why?

8. **After** your response, will you come back and check the same thread again? In what cases will you come back? In what cases in which you won't?
   a) How do you describe the frequency of your visits to the same thread? (For example: you come back only one time and reply all posts you read, or you come back from time to time.)

b) Do users ever have difficulty in following your instructions in your suggestion? [**E.g**. were there any other posters that have ever asked you to give a better elaboration/explanation to your suggestion?]

c) How often do you have to clarify your own solution to the poster? How does this impact your feelings or experiences with using the discussion board?

Do you have any other opinions you want to share with us about this forum or about our questionnaire?